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Enersolve Demonstration Project

Nestlé Ltd.

Chesterville, Ontario

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REQ. NO. 2-9055-5

CONTRACT REPORT NO. OSQ82-00125

PRE-ENGINEERING ASSESSMENTS OF ENERSOLVE DEMONSTRATION PROJECTS

Enersolve Demonstration Project

Nestlé Ltd.

Chesterville, Ontario

BFH/S Reference 30901-7000

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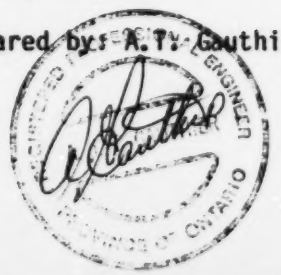
Prepared by: A.T. Gauthier, P.Eng.



A DIVISION OF Lavalin

Enersolve Demonstration Project
Nestlé Ltd., Chesterville, Ontario
BFH/S Reference 30901-7000

TABLE OF CONTENTS

		Page
1.0	EXECUTIVE SUMMARY	1
2.0	INTRODUCTION	3
3.0	TECHNICAL DISCUSSION	
.1	Boilers Identification - Preliminary Visit	4
.2	No. 2 Boiler and Auxiliaries Identification - Site Survey	4
.3	No. 2 Boiler Efficiency Testing	5
4.0	RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS	
.1	Recommended Instrumentation Changes	11
.2	Recommended Boiler Improvements	13
.3	Costs/Benefits Analysis	14
.4	Cost Estimates for Project Engineering	14
5.0	GENERAL DISCUSSION AND CONCLUSIONS	16

APPENDICES

A Preliminary Visit Report

B Boiler No. 2 Equipment Identification Site Survey

C Test Results and Charts

D Statistics Canada: Copy of Coffee Stocks Report

1.0 EXECUTIVE SUMMARY

The Enersolve program under which this study was performed is concerned with increasing the efficiency of utilization of oil, gas and waste fuels in industrial processes. This stage of the Enersolve program is intended to support a limited number of site-specific retrofit projects as a means of documenting for industry the economics of such retrofit projects to older equipment.

As a first step in examining the feasibility of the concept, a 25,000#/hr stationary converted waste fuel boiler was identified and tested at the Nestlé Food Processing Plant in Chesterville, Ontario.

Due to the contingencies of physical configuration of the unit and to the limited documentation available, an ideal heat loss testing method could not be completed. Using compromised known and measured quantities on site, a modified Input-Output method was completed to obtain satisfactory evaluation results for potential savings. Further discussion of the results of testing and summary of comments are presented in Sections 3.3.5 and 3.3.6 of this report.

It was estimated that some $225,000 worth of control retrofit and recommended boiler modifications could result in efficiency improvements and reduce fuel requirements valued at $210,000 based on continuous operation of the boiler. The plans and specifications could be done within three months, expenditures within twelve months, followed by a monitoring period of nine to twelve months.

It is recommended that the implementation be done under the assumption that the unit will be used for more than 2,000 hours per year in the future, as it cannot otherwise be cost-effective and representative for demonstra-

1.0 EXECUTIVE SUMMARY (cont'd)

tion. The plant operating conditions at Nestlé are changing rapidly and this should, therefore, be taken into account before implementation takes place.

2.0 INTRODUCTION

In response to a proposal call to apply the EMR CANMET Enersolve Program, our firm identified an acceptable unit owned by Nestlé in Chesterville, Ontario. Nestlé expressed their verbal interest in the program and offered their full co-operation in such a study.

A contract for assessment of the program was granted to Shawinigan and further identification was carried out during a site visit where up-to-date operating conditions and characteristics were discussed with the company representatives.

Our firm acknowledges the participation of Segetherm Inc., a Division of Lavalin, for the boiler testing and recommendations for controls retrofit. The on-site boiler staff was co-operative in supporting tradesmen during the two-day testing period for adjustments, calibration and weighing waste combustion products.

Our testing and assessment had to be scheduled in compliance with the safe and regular operations of the plant, as well as the unpredicted production runs which added unforeseen complications to obtaining the necessary steady state operating conditions. However, we were able to obtain enough data to verify the efficiency of the unit and establish a base for comparison when changes are implemented.

In our opinion, the loads swings experienced are the daily operating conditions of the unit, and it is under these conditions that the retrofit controls should improve efficiency as they are not likely to change in the future.

3.0 TECHNICAL DISCUSSION

.1 Boilers Identification - Preliminary Visit

For the purpose of identifying the unit, a preliminary visit to the Nestle boilers was made on October 28, 1982 when the application of the program was discussed with the owner's representative, the testing firm retained for the project, and the consulting engineer.

The report and assessment done during that visit is presented in Appendix A of this report, and the findings were verbally discussed with Energy, Mines & Resources (EMR) subsequent to our findings of that date. It was then decided to pursue our assessment for the No. 2 waste fuel boiler as the prime candidate for control retrofit under the circumstances.

.2 No. 2 Boiler and Auxiliaries Identification - Site Survey

A detailed identification of Unit No. 2 was made by the consulting engineer during a site survey on November 24, 1982. Operation was also discussed with the operators to identify specific problems and conditions. The results of the findings are presented in Appendix B for the following items and/or components:

.1 Boiler Identification (make, model, capacity, etc.).
.2 Fan Details.
.3 Gas Burners.
.4 Boiler Controls.
.5 Soot Blowers.
.6 Boiler Feedwater Pumps.
.7 Steam Meters.
.8 Gas Meters.
.9 Boiler Stack.
.10 Miscellaneous Other Components.

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing

This section is an extract from the report of Segetherm Inc., who were retained to do the actual testing of the unit. Their report is presented in Appendix C of this report.

.1 General

No. 2 boiler, as identified in Appendix B, is a three-drum Waterous unit built in 1948. It has a maximum continuous rating of 25,000 lbs/hr at 200 psig saturated. The boiler is fuelled by natural gas and coffee grounds in varying proportions. The quantity of coffee grounds depends on production plant output and the type of coffee being manufactured. "Nescafé" coffee accounts for approximately 90% of the coffee production and "Encore" coffee the remaining 10%.

.2 Boiler Operating Conditions

No. 2 boiler carries the bulk of the manufacturing plant 200 psig steam load and is subject to wide and rapid load swings from the various manufacturing departments. This load swing can be as high as 60% boiler load or 15,000 lbs/hr. Even under normal production plant operations (when the 60% load swing does not occur), the load varies by 20% or 5,000 lbs/hr. (See Figures 1 and 2, steam flow charts, and Appendix C.)

During the efficiency tests, every attempt was made to obtain steady boiler steam flow conditions, but wide steam flow fluctuations still occurred. This type of operation is not conducive to good boiler testing and therefore introduces errors into the results. (See Figure 1 for steam flows firing natural gas only, and Figure 2 for steam flows while firing coffee grounds and natural gas.)

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing (cont'd)

.3 Coffee Grounds

As stated earlier in the report, "Nescafé" accounts for approximately 90% of the coffee production. These boiler tests were carried out using "Encore" coffee grounds and is not, therefore, representative of the bulk of the refuse fired. "Encore" coffee comprises approximately one-third chicory and two-thirds coffee, whereas "Nescafé" is 100% coffee. In addition to the grounds, small quantities of chaff, which is the thin husk from the coffee roasting process, are also burned in the boiler. No measure of the quantity of chaff is available.

It is assumed that the above refuse was still representative in nature of the regular coffee grounds and somehow confirmed by the ultimate analysis that was done. In fact, the higher heating value was found within some known range and ultimate content as well. A weighing procedure was specially prepared and done and known volumes of grounds were burnt. Details and calculations are presented in Appendix C.

.4 Storage Silo

The coffee grounds are blown from the process plant to the steam plant with 200 psig steam, into a storage silo. The grounds exit the silo to one of two chain conveyors. Each chain conveyor has a knife gate to isolate the grounds. Unfortunately, one of the two slide gates was stuck in the open position which resulted in wet coffee grounds running through the silo and the moisture press to the boiler. Without a constant head of material on the press, its moisture removing ability varied as did the ability to control the output. Despite these problems, reasonably steady flow rates of coffee grounds were maintained for the tests.

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing (cont'd)

.5 Test Procedure

All four tests were carried out in the "as found" condition. No attempt was made to tune the boiler by adjusting air flows or air pressures.

Two tests were carried out on natural gas only, one for a period of one hour with an average steam flow of approximately 14,000 lbs/hr; the second for a period of 30 minutes at an average steam flow of approximately 18,000 lbs/hr, which was the maximum available for that day.

Two further tests were carried out on natural gas and coffee grounds. One for a period of 53 minutes with an average steam flow of approximately 20,000 lbs/hr, and the second for a period of one hour with an average steam flow of approximately 13,000 lbs/hr. In each case, the coffee grounds feed rate was fixed for the test and with the same feed rate, dumped into a pre-weighed container, which was re-weighed when full. This way, a reasonably accurate weight was obtained.

For all tests, gas and steam flows were taken from the respective integrators, oxygen analyses taken with a Hagen portable analyser, carbon dioxide with a Fyrite, and temperatures with Thermoelectric and Omega temperature indicators. Furnace draft was checked with an inclined manometer and system pressures with a magnehelic gauge, both of Dwyer manufacture. Ambient, feedwater and coffee grounds temperatures were taken with mercury in glass thermometer.

Neither air flows or waste gas volumes could be measured.

There was no blow-down during the test.

Only steam flow measurement could be used and it could be verified against feedwater measurement as it is non-existent.

The overfire air fan was shut down during the test.

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing

.5 Test Procedure (cont'd)

The input-output method of testing was selected because the purpose of the test was to determine the boiler operating efficiency. This method of calculating the efficiency takes into account all operating conditions that influence the efficiency. In this case, unmeasurable undergrate air, tramp air, radiation loss and variable feed water temperature are factors that affect the thermal efficiency and would not have appeared in a heat loss method which is strictly an instantaneous combustion efficiency test method, and does not account for variable operating conditions. Furthermore, unknown volumes of tramp air and undergrate air render meaningless the results from the gas analysis as boiler efficiency.

It is felt, based on experience, that the overall efficiency of a unit under changing plant conditions is best determined by the input-output method. Even if this method could be, at times, less accurate than the heat loss method, it is more representative of the actual boiler efficiency, especially when the conditions are constantly varying.

.6 Conclusion of Tests and Results

Based on the tests and observation of operations, we have reached the following conclusions:

.1 The unit as tested was running at approximately 61% efficient.

.2 It should be noted that the carbon in ash was not taken into account because the quantity of ash under the stoker is negligible on an hourly basis. The ash from the final dust collector could be re-injected into the boiler if the flue gas does not get overloaded with dust.

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing

.6 Conclusion of Tests and Results (cont'd)

.3 Reducing the vast quantities of both tramp air and excess combustion air to the boiler would improve efficiency greatly. An improvement of 10% would not be unrealistic.

When firing natural gas alone, the exact quantity of combustion air could be supplied with just sufficient undergrate air to keep the grate cool.

.4 It may be possible to burn the coffee grounds alone and eliminate the natural gas for the lower steam loads. This, of course, would depend on tests which would have to be carried out on the boiler with a reduced grate area, varying depths of fuel bed and varying undergrate air pressures.

Wood refuse boilers can operate without auxiliary fuel and this may well be possible with coffee grounds. However, the same operating principles must prevail, i.e. steady flow, even grate distribution, and moisture content as low as possible from the press (around 50% to maximum 55%).

.5 Tests No. 1 and 2 reveal the boiler efficiency while firing natural gas. The results are substantially the same. Test No. 2 shows a slightly better efficiency, mainly caused by the higher feed water temperature. By interpreting the flue gas analysis, it is found that the boiler is operating at 128% excess air, as this type of burner normally operates in a range of 10 to 15% excess air. The abnormality is caused by the unmeasurable undergrate air which dilutes the combustion gas and the interpretation of the analysis as efficiency is not accurate. The input-output method shows that the boiler operating efficiency is low and controlling the volume of undergrate air would improve the overall thermal efficiency.

3.0 TECHNICAL DISCUSSION

.3 No. 2 Boiler Efficiency Testing

.6 Conclusion of Tests and Results (cont'd)

Tests No. 3 and 4 give results of thermal efficiency while burning coffee grounds and natural gas. The differences in efficiencies (70% in case 3 and 62% in case 4) are attributed to the temperatures of the feed water (197°F vs. 166°F); the moisture content of the grounds (55.2% vs. 62.4%); and steam generating output (75% vs. 45% of MCR). Due to the constant flow of undergrate air, at a reduced load the thermal efficiency is affected by the large unnecessary volume of undergrate air.

The input-output method used for evaluating this boiler under normal plant operating conditions has provided an indication of the level of operating efficiency, has revealed the factors that influence the overall boiler efficiency, and the necessity of providing for this type of installation better measuring and controlling systems in order to obtain the best possible gains from the combustion of industrial wastes.

.7 Calculation summaries for tests #1, #3 and #4 using the heat loss method to determine efficiency are presented in Appendix C of the report. The results compare favourably with the input-output method followed.

Reference for calculations:

Combustion Handbook for Canadian Fuels (1974), EM&R.
By F.D. Friedrich and A.C.S. Hayden

4.0 RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS

.1 Recommended Instrumentation Changes

The proposed control scheme is as described below and per the attached sketch.

.1 Auxiliary fuel (natural gas) combustion control

The firing rate is according to changes in steam header pressure received from the plant master controller which is being supplied with the new boiler. These changes increase or decrease the quantity of natural gas fired and hence maintain steam outlet pressure constant. The system foreseen here will be a conventional cross limiting type where sufficient air is always maintained to prevent a fuel rich furnace atmosphere and hence prevent the possibility of furnace explosions.

The major problem with this scheme is to obtain a reliable and repeatable measurement of the air flow being used for combustion of the natural gas. It is, therefore, proposed to install an averaging pitot tube in the combustion air duct and verify its location by a series of air flow tests to ensure there is no stratification, and install suitable air flow vanes in the duct to eliminate any problems detected.

.2 The gas flow is presently measured by a positive displacement meter and this can be modified to give a signal suitable for control purposes.

.3 Oxygen in flue gas will be analysed and indicated as an operating guide to reduce the quantity of excess air being fired.

.4 The feed rate of coffee grounds will be manually adjusted according to availability.

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4.0 RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS

.1 Recommended Instrumentation Changes (cont'd)

.5 Air flow to the coffee grounds (undergrate air flow) will be calculated by measuring the steam flow from the boiler and subtracting from this the steam flow produced by natural gas, thus obtaining the steam flow produced by the coffee grounds. This signal is used as the air requirement for coffee grounds and this is not used as the set point for the undergrate air flow controller.

Measuring the actual undergrate air flow is the main problem, but this can be accomplished by installing a matrix type pitot assembly at the inlet to the undergrate air fan. This type of assembly has a straightening type of honeycomb arrangement to eliminate the effect of eddy currents and stratification and will give an accurate repeatable flow measurement.

.6 The drum level control will be changed from the thermo-hydraulic system presently installed to a two-element type which senses changes in steam flow and reacts from these to prevent surges and swells in the boiler drum and thus minimize carry-over of condensate into the steam outlet header.

.7 The furnace draft will be controlled in relation to the measurements from a new furnace draft transmitter. The control will adjust the boiler outlet damper.

.8 The control system proposed for the boiler is that manufactured by Bailey Meter Company, the Network 90 system which is a state-of-the-art microprocessor-based control. It is selected since it can fit into existing system cabinets, can be accessed through the existing CRT-based operator control station and therefore makes an integrated control system.

4.0 RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS

.2 Recommended Boiler Improvements

.1 Detroit Rotostoker

The hopper at the inlet to the rotostoker was designed to be continuously full of coal. This is not possible with coffee grounds as they would bridge and not feed to the boiler. In consequence, a large quantity of tramp air is drawn in with the grounds, which is excess to combustion requirements. Reducing this tramp air by sealing off a portion of the rotostoker inlet would improve combustion conditions.

The rotostoker tends to throw the grounds in two parallel rows on the grate, but not covering the whole grate area. An improvement in the distribution pattern to spread the grounds over a wider area would improve combustion.

.2 Grate Area

In addition to the improved distribution in .1 above, the grate area could be reduced by covering with refractory and building an incline to the furnace sides.

This modification would force all the undergrate air through the coffee grounds on the grate, and prevent it flowing through the boiler system as effective dead load.

.3 Fuel Bed

Having improved the distribution and reduced the grate area, operating tests can be carried out with varying depths of fuel bed. If it is at all possible, it would improve the operation if a 2" to 3" bed could be maintained on the grate at all times.

.4 Economiser

With boiler outlet temperatures around 600°F, an economiser could be retrofitted with positive results.

.5 Deaerator

While the effect on efficiency would not be great, maintaining the feedwater temperature above 212°F would ensure oxygen removal

4.0 RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS

.2 Recommended Boiler Improvements

.5 Deaerator (cont'd)

from the feedwater in the deaerator and reduce the possibility of internal corrosion. Throughout the four tests, the feedwater temperature varied between 158°F and 213°F!

.3 Costs/Benefits Analysis

There are no precise data available to define the amount of waste and natural gas burned by Boiler No. 2, however, from our observations as well as practical experience, the approximate yearly plant load is 262,000 MMBTU. From the 1981 natural gas cost of $713,000 at a unit price of $6/MMBTU including efficiency factor, we deduct that some 118,000 MMBTU was obtained which leaves a 55% contribution obtained from waste beans. An improvement of 10% of the waste burning as claimed by the proposed retrofit represent a direct saving on gas of 14,400 MMBTU/year, presently valued at $122,000 per year, and the same improvement on the remaining portion of natural gas estimated at 10,360 MMBTU/year, will increase these savings by another $88,000. This represents a reduction of 21% from the expected gas usage at today's conditions.

The total estimated capital cost for controls retrofit is $150,000, and $75,000 for the boiler modifications. With an estimated 1.1 year payback for a complete job the savings remain attractive even if the boiler is on load 25% of the time.

.4 Cost Estimates for Project Engineering

The total engineering fees that will be charged for plans and specifications, supervision, and the nine-month monitoring period phase of the retrofit are $32,500, allowing 70% for the design phase, and 30% to the supervision and monitoring phase.

4.0 RECOMMENDATIONS FOR RETROFIT AND COSTS/BENEFITS ANALYSIS

.4 Cost Estimates for Project Engineering (cont'd)

The actual anticipated time frame for the project implementation is three months for the design stage, twelve months for implementation, followed by nine months of monitoring.

5.0 GENERAL DISCUSSION AND CONCLUSIONS

The assessment study has enlightened the feasibility and value of controls retrofit for efficiency and improvement of old waste-fuel boilers.

It has been demonstrated that when the actual performance of waste-fuel boilers can be improved by the upgrading of the control system and some modifications of the fuel handling system, the overall efficiency when burning refuse fuel will be improved and the consumption of the support fuel will be reduced.

The emphasis on the value of waste burning is self-explanatory. Firstly, the waste must be disposed of. Secondly, the optimized calorific value (heat efficiency) is a major fuel saving.

Due to the lack of appropriate control system and/or inadequate waste fuel handling and burning system, the combustion process turns out to be a mere incineration system yielding very little energy.

The testing conducted under the Enersolve program has demonstrated the potential results that can be obtained with the implementation of the program under study. From our source of information, there are only two known companies in Canada burning waste coffee beans, and Statistics Canada reports lead us to the conclusion that there are over 8,000 tons/year of coffee waste available for similar combustion processes. In terms of Nestlé's capacity, it appears that only two plants could be supported by this incineration process, but there are thirty-two reported companies across Canada that are producing coffee, the majority of them situated in Quebec (12) and Ontario (11). There are two in New Brunswick, two in Manitoba, and five in British Columbia. Due to the limited number of units available, the program should be extended to evaluate the potential in other industries where waste fuel is available.

5.0 GENERAL DISCUSSION AND CONCLUSIONS (cont'd)

This study has demonstrated in a general sense that, due to the variable consistency of waste fuel (moisture, calorific value, feed rate, etc.), this type of combustion process does require a more elaborate control system and burning equipment in order to gain the maximum savings obtainable by substitution of fossil fuels with waste fuels and reduction of support combustion fuels.

As per the present scheme of expenditure, Boiler No. 2 is to become a standby unit on short-term basis to the new waste boiler presently under construction. The unit must be kept in top running condition and functional for that purpose. Replacement is planned on longer terms (5 to 10 years). The overall assessment is favourable to the proposed retrofit of the #2 unit, with the reservation that sufficient operating hours (2,000 per year minimum @ 50% load condition) will be scheduled for the future. However, the anticipated hours of operation cannot be predicted precisely at the moment. We consider the unit as a prime candidate for demonstration and monitoring, but we have some reservations with respect to obtaining its full potential savings under the present circumstances.

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Enersolve Demonstration Project
Nestlé Ltd., Chesterville, Ontario
BFH/S Reference 30901-7000

APPENDIX A

PRELIMINARY VISIT REPORT

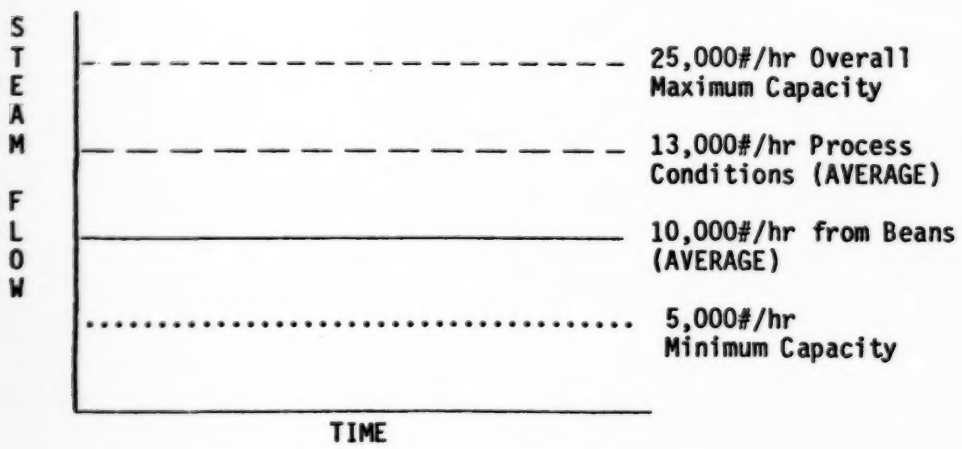
OCTOBER 28, 1982

Enersolve Demonstration Project
Nestlé Ltd., Chesterville, Ontario
BFH/S Reference 30901-7000
Appendix A

SCHEMATIC OF BOILER LOADS AND DATA

BOILERS:	40,000#/hr B-1	25,000#/hr B-2	OUT B-3
FUEL TYPE:	Gas	Gas and C.G. Beans 50% Moisture	

LOADS AND DATA:	24-hour Operation (12 hours on daytime for measure)
WASTES:	2,000#/hr 10,000#/hr storage
PRESSES:	5,200#/hr max. 3,000/hr min



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INTERNAL CORRESPONDENCE

TO: JEF DATE: November 1, 1982

REF: Project # 30901 FROM: A.T.G.- Project Co-ordinator

SUBJECT: REPORT OF SITE VISIT TO NESTLES-CHESTERVILLE ONTARIO
OCTOBER 28, 1982 - CANMET

On October 28th, the writer visited the above mentioned plant for the purpose of identifying the present conditions of the three(3) boilers that they have in operation. Also present, were two representatives of our parent company, MMG, Lavalin Inc, namely Howard Brooks and Ian W. Henderson.

The party met Bryan Beazer, Plant Operation Manager, who gave us a tour of the boiler house and then proceeded to explain the present status of operation of their boilers.

1. The largest boiler (#1 Unit) Vickers, Watertube, Package Type, is namely rated for 40,000 #/hr of steam at 300 P.S.I. The Unit is natural gas fired and runs on standby to two waste boilers of 25,000 #/hr. capacity each. The load conditions of that boiler is most of the time minimum, as it provides 3,000 #/hr. of special process steam at 250 P.S.I. and takes the higher serving loads off the waste boilers through 1 P.R.V. station set at 210 P.S.I. Another P.R.V. station, set at 225 P.S.I., serves as a relief line into the 210 P.S.I. system whenever the 250 P.S.I. load is less than minimum fire load. Boiler is used more often during winter time due to building heating loads.

2. A second unit (#2 unit) is a Waterou s, stationary type, originally coal-fired boiler, converted to burn waste coffee beans, and #2 oil, and natural gas. The capacity of that boiler is rated for 25,000 #/hr. of steam at 210 P.S.I. pressure. That unit is to stay and will be used as a standby unit to the new waste boiler.

3. A third unit (#3 unit) is identical to #2 unit and will be removed to be replaced in the near future by a new B. & W. waste boiler C/W net -.90 controls. The unit will be rated for 40,000 #/hr. of steam at 300 P.S.I.

4. The loads requirements of the plant is 13,000 #/hr. for process steam and 25,000 #/hr. overall steam load. Surges or catch-up loads are the justification for the higher 40,000 #/hr. capacity.

..2

5. The waste beans are produced at a rate of 2000 #/hr. and they have a moisture content of 75-80%. The waste silo has a capacity of 10,000 # of wastes. Waste beans must be disposed of first by burning them.

6. Waste dewatering is done by 2 presses that reduce moisture content to 50% before the beans are fed to either of the waste boilers at two possible rates of 3,000 or 5,300 #/hr.

7. The present accepted heat value of the beans is 11,000 BTU/lb. and 10,000 #/hr. of steam is obtained from the beans. Therefore, a rough calculated efficiency appears to be output/input times 100%.

$$= \frac{10{,}000\ \#/hr \times 1200\ BTU/\#}{(2{,}000\ \#/hr \times 11000\ BTU/\#)} = \frac{12.0\ MMBTU}{22.0\ MMBTU} = 54\%$$

ATG/sb

Enersolve Demonstration Project
Nestlé Ltd., Chesterville, Ontario
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Appendix A

PRELIMINARY IDENTIFICATION OF COMPONENTS

No. 2 and 3 Boilers

Fan Details

F.D. Fan	-	Canadian Sirrocco, C28204, 15 HP, 220 V, 1800 R.P.M., 1948
Combustion Air Fan	-	Chicago Blower, Class 11, Size 20, A 13383, 10 HP, 460 V, 1720 R.P.M., 1971
Overfire Air Fan	-	Eclipse, SM-6812, 1½ HP, 40,000 c.f.h., July 1971

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APPENDIX B

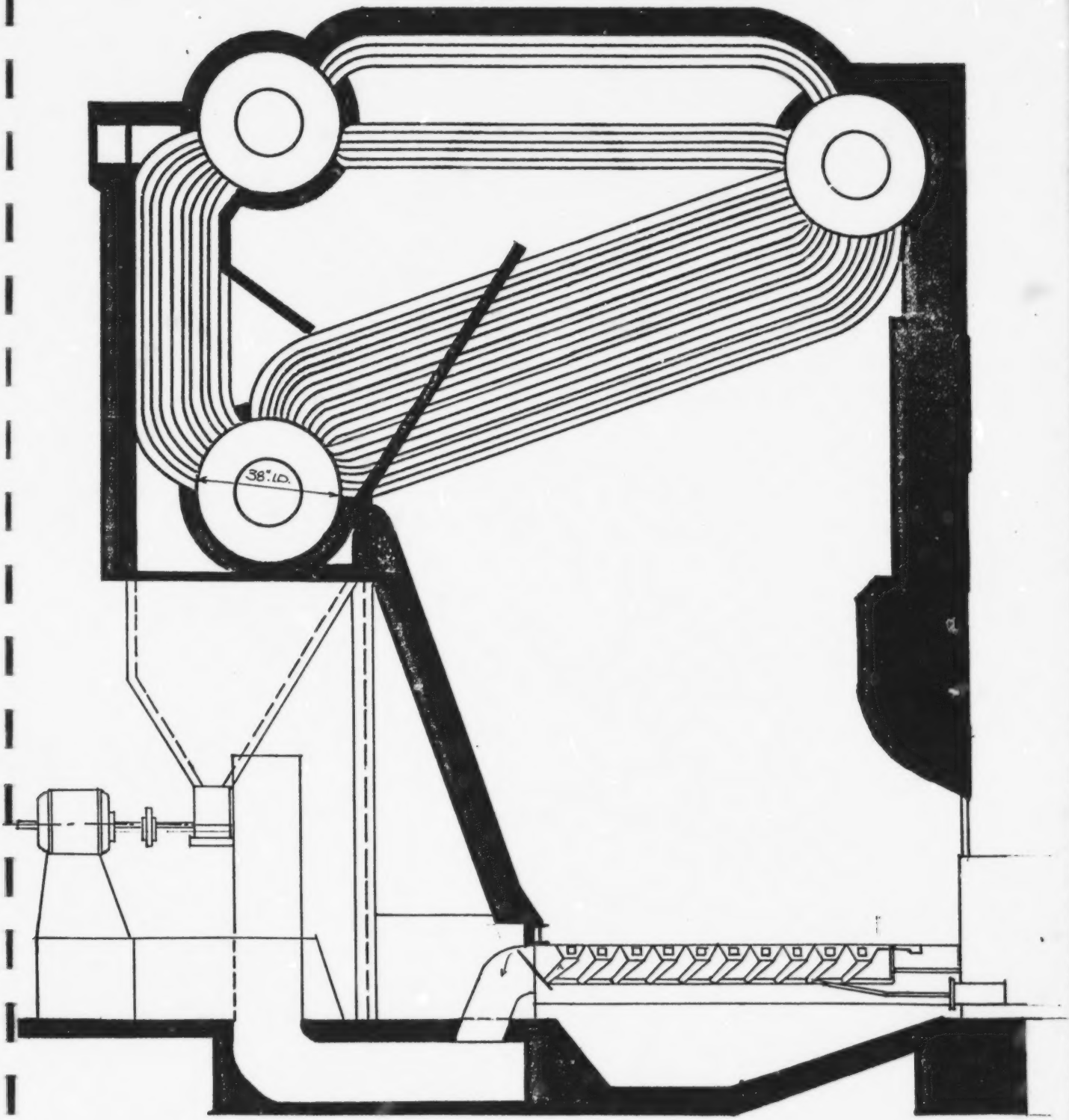
BOILER NO. 2

EQUIPMENT IDENTIFICATION SITE SURVEY

NOVEMBER 24, 1982

FIELD NOTES REPORT

NO. 2 BOILER SECTION SCHEMATIC
NESTLÉ CHESTERVILLE ONT.



LIST OF EQUIPMENT IDENTIFIED

1. NO. 2 BOILER IDENTIFICATION
   - Make: Waterous Boiler, 350 H.P.
   - Model: Type L, 225# W.P.
   - Capacity: 350 H.P.
   - Heating Surface: 3404 sq.ft. E.D.R.
   - Tubes: 3¼"O.D., 11 BWG (120)

   Notes: Manufacturer is Waterous Ltd., Brantford.
   Present combustion service is done by Volcano.

2. FAN DETAILS

   .1 Forced Draft Fan No. 2
   - Sirocco Windzor, Size 245, Type H.S.
     Motor: 15 H.P., 460 Volts, 1800 R.P.M.
   - S#C-28204

   Notes: Draft control done with Honeywell Modutrol Motor M954-A.

   .2 Overfire Blower
   - Turb-Blower by Eclipse, 6 oz.
   - Eclipse SM6812: 1½ H.P.
   - Capacity: 40,000 S.C.F.H.
   - C#28840, P.O. #21150

   Notes: Fan is c/w special air nozzle arrangement and forms part of gas burner conversion 1971.

   .3 Combustion Air Blower No. 2 (Underfire Fan)
   - Supplied by Eclipse 1971
   - Chicago Blower Class II, Size 20
   - A13383, 10 H.P., 460 V, 1720 R.P.M., 1971

   or

LIST OF EQUIPMENT IDENTIFIED

2. FAN DETAILS

.3 Combustion Air Blower No. 2 (Underfire Fan) (cont'd)

- Eclipse Class II - Arr. 9
- Capacity: 7,000 C.F.M.
- Motor: 10 H.P., 460 V, 1720 R.P.M.
  Brook Electric, Frame K215T, D.P. Amps 27/135
  S#X672804

3. GAS BURNERS

- Eclipse 16R2-10, S#6641-2
- Capacity: 36,000,000 B.T.U. @ 10 P.S.I. 34,000 C.F.H.
- Gas Inlet Pressure: 15#
- Gas Outlet Pressure: 5#

Notes: In 1963, conversion from coal to #2 oil firing took place, which equipment is still in operating condition.

The specifications for the oil firing system are as follows:

- Supplied by Eclipse Fuel-Engineering.
- Eclipse Oil fuel conversion drawing D-6641-6, H-82 to #2 Boiler 240 USGPH.
- Oil Burners: 2 Todd Vee-Cee Oil Guns
  Oil Tips #28
- Capacity: 240 USGPH @ 300 P.S.I.
- Oil Pumps: Wortington #3 GARM
  15.5 USGPM @ 300 P.S.I.
  Driven by 5 H.P. Motor for #2 oil.
- On coal #2 stoker had a Viri-Speed Driver
  1 H.P., 460 V, 1800 R.P.M. from Reeves Pulley Co. (1948).

LIST OF EQUIPMENT IDENTIFIED

4. BOILER CONTROLS

Namely, Semi-Automatic:

- Cash Combustion Control S#294, Type 100 W.C., by Lytle Engineering Co., complete with auxiliary hand control valve.
- Draft by Honeywell Modulating Motor M954A.

Notes: - Level control with Copes Regulator.
- Low level cut-out (float type)
- Manual waste feed system for zero, 1 press or 2 presses.

5. SOOT BLOWERS

Vulcan Job #19981, S#1146F, Drawing V-16653 for steam @ 225#, 397°F using 8-LG-3 rotary heads.

Note: Soot blowers in operating condition used regularly.

6. BOILER FEEDWATER PUMPS

- Two Smart-Hayward-Turner 4-stage Centrifugal Model 2MA-4 ST Type A - Horizontal S#760624 and 760625
- 50 H.P., 230/460 V, 3550 R.P.M.
- Capacity: 100 USGPM @ 540 ft. T.D.H.
- Horizontal split cage centrifugal pumps 7-5/8" diameter impeller - flooded suction for .955 SP.GR. water @ 220°F temperature.

Note: Actual temperature variation was from 150°F to 220°F.

7. STEAM METERS

Republic steam flow meters. Flanged orifice type with D/P cell transmitters.

8. GAS METERS

Rockwell gas flow meters and indicators.

LIST OF EQUIPMENT IDENTIFIED

9. BOILER STACK

Hot gases are piped to the boiler house main chimney which collects from three existing boilers without the use of I.D. fans.

10. MISCELLANEOUS OTHER COMPONENTS

.1 Deaerator

Specially made type deaerator operated at 3# pressure and heated with injection of steam in water tank with sparger.

.2 Boiler Masonry and Refractory

Original refractory by Plibrico #592-A.

Note: The masonry and refractory of #3 unit was inspected and found to be in acceptable condition for operation. It is assumed that #2 is in a comparable, if not better, state.

Shawinigan

APPENDIX C

TEST RESULTS

AND

CHARTS

WEIGHT OF COFFEE GROUNDS (WET BASIS)

Test 3 = 1250 lbs in 25 minutes

= 3000 lbs/hr at 55.2% moisture ... 1644 #/hour (dry basis)

Test 4 = 1286 lbs in 33 minutes

= 2338 lbs/hr at 62.8% moisture ... 879 #/hour (dry basis)

ESTIMATES LOSSES

1.- Generating bank and boiler outlet hopper

(i) Firing Nescafé 300 lbs/week

(ii) Firing Encore 100 lbs/week

2.- (i) Firing Nescafé 350 lbs/day

(ii) Firing Encore 100 lbs/day

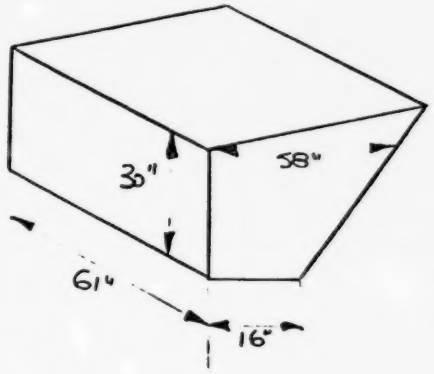
VOLUME OF SKIP

30 X 16 X 61 = 29280 cu ins.

& $\frac{46 \times 30 \times 61}{2}$ = 42090 cu ins.

71370 cu ins.

÷ 1728 = 41.3 ft³



DENSITY OF COFFEE GROUNDS (WET BASIS)

$\frac{1250 \times 1286}{2} = \frac{1260}{41.3}$

= 30.7 lbs/ft³

ENERSOLVE DEMONSTRATION PROJECT

NESTLE LIMITED - CHESTERVILLE ONTARIO

NO. 2 BOILER EFFICIENCY TEST RESULTS

DATE: 23/11/82

TEST NO.	ITEM	UNITS	TIME						
			14.45	14.55	15.05	15.20	15.45	Ave	TOTAL
	Steam Flow (Chart)	0-100%	0.61	0.53	0.58	0.59	0.58		
	Steam flow (integrator) X 10	lbs/hr	2598				3965		13,670
	Steam pressure (GA)	psig	200	200	200	195	195	198	
	Natural gas flow (integrator)	x 2.006 MCFH	127				139		24,072
	Natural gas flow (indicator)	x 2.006 MCFH	12.30	12.30	12.30	12.30	12.30	12.3	24,674
	Feedwater Temp.	°F	[1]158	165	182	196	200	180	
	Ambient air temp.	°F	80	81	80	79	80	80	
	Wet bulb temp.	°F	56	56	55	54	56	56	
1	Preheat air temp.	°F	113	111	114	116	-	113.5	
	Coffee grounds temp.	°F	—	—	—	—	—	—	
	Waste gas boiler outlet [2]								
	Temp.	°F	612	611	609	616	-	612	
	$\%CO_2$		3.0	2.8	2.0	3.0	-	2.7	
	$\%O_2$		12.8	13.5	13.6	12.8		13.1	
	Furnace pressure	WG	-0.11	-0.13	-0.15	-0.13	-	-	

1.- Steam switched onto DA at beginning of test.

2.- Sample point changed

ENERSOLVE DEMONSTRATION PROJECT

NESTLE LIMITED - CHESTERVILLE ONTARIO

NO. 2 BOILER EFFICIENCY TEST RESULTS

DATE: 23/11/82

TEST NO.	ITEM	UNITS	TIME							
			16.06	16.35	AVE	TOTAL				
	Steam Flow (Chart)	0-100%	0.71	0.73	0.72					
	Steam flow (integrator) X 10	lbs/hr	4570	5430		17793				
	Steam pressure (GA)	psig	200	200	200					
	Natural gas flow (integrator)	x 2.006 MCFH	144	151		29,052				
	Natural gas flow (indicator)	x 2.006 MCFH	14.50	14.0	14.25	28,586				
	Feedwater Temp.	°F	213	210	212.5					
	Ambient air temp.	°F	-	-	80					
2	Wet bulb temp.	°F	-	-	56					
	Preheat air temp.	°F	115	113	114					
	Coffee grounds temp.	°F	-	-	-					
	Waste gas boiler outlet									
	Temp.	°F	616*	616	616					
	$\%CO_2$		3.0	5.5	-					
	$\%O_2$		12.8	10.4	-					
	Furnace pressure	WG	- 0.13	- 0.06	-					

*Problems experienced with sampling point.
Sample point changed

ENERSOLVE DEMONSTRATION PROJECT

NESTLE LIMITED - CHESTERVILLE ONTARIO

NO. 2 BOILER EFFICIENCY TEST RESULTS

DATE: 24/11/82

TEST NO.	ITEM	UNITS	TIME							
			10.51	11.03	11.10	11.22	11.35	11.44	AVE	TOTAL
	Steam Flow (Chart)	0-100%	0.70	0.70	0.75	0.76	0.75	-	0.732	
	Steam flow (integrator)	lbs/hr	38980					40719	-.	19687
	Steam pressure (GA)	psig	196	195	195	200	195	-	196	
	Natural gas flow (integrator)	x 2.006 MCFH	373					378	-	11355
	Natural gas flow (indicator)	x 2.006 MCFH	5.6	5.6	5.6	5.5	5.6	5.6	5.6	12717
	Feedwater Temp.	°F	202	190	185	192	206	209	197.3	
	Ambient air temp.	°F						79		
3	Wet bulb temp.	°F						58		
	Preheat air temp.	°F	121	121	120	121	121	121	121	
	Coffee grounds temp.	°F								110
	H_2O	%								55.2
	weight	lbs								3000
	Waste gas boiler outlet									
	Temp.	°F	580	584	582	586	585	587	584	
	$\%CO_2$		9.0	7.5	10.6	8.0	7.5	9.5	8.7	
	$\%O_2$		10.2	10.2	8.5	10.6	10.7	9.9	10.0	
	Furnace pressure	WG	- 0.13	- 0.07	- 0.10	- 0.12	- 0.12	-0.10	-	

ENERSOLVE DEMONSTRATION PROJECT

NESTLE LIMITED - CHESTERVILLE ONTARIO

NO. 2 BOILER EFFICIENCY TEST RESULTS

DATE: 24/11/82

TEST NO.	ITEM	UNITS	TIME							
			14.14	14.25	14.36	14.45	15.05	15.15	AVE	TOTAL
	Steam Flow (Chart)	0-100%	0.48	0.5	0.42	0.49	0.52	-	0.48	
	Steam flow (integrator)	lbs/hr	5080					6340		12600
	Steam pressure (GA)	psig	197	196	196	195	195	-	196	
	Natural gas flow (integrator)	x 2.006 MCFH	71402					71408		12036
	Natural gas flow (indicator)	x 2.006 MCFH	6.0	6.0	6.0	6.0	6.0	6.0	6.0	12036
	Feedwater Temp.	°F	160	161	160	160	185	200	198	
	Ambient air temp.	°F						74	74	
4	Wet bulb temp.	°F						55	55	
	Preheat air temp.	°F	118	118	-	118	118	120	118.4	
	Coffe grounds temp.	°F								118
	H_2O	%								62.8
	weight	lbs								2338
	Waste gas boiler outlet									
	Temp.	°F	534	553	532	550	555	561	547.5	
	$\%CO_2$		6.0	5.0	5.0	6.0	6.0	6.5	5.75	
	$\%O_2$		11.9	12.5	12.8	11.6	10.9	11.3	11.8	
	Furnace pressure	WG	- 0.11	- 0.10	- 0.13	- 0.07	-0.09	-0.12	-	

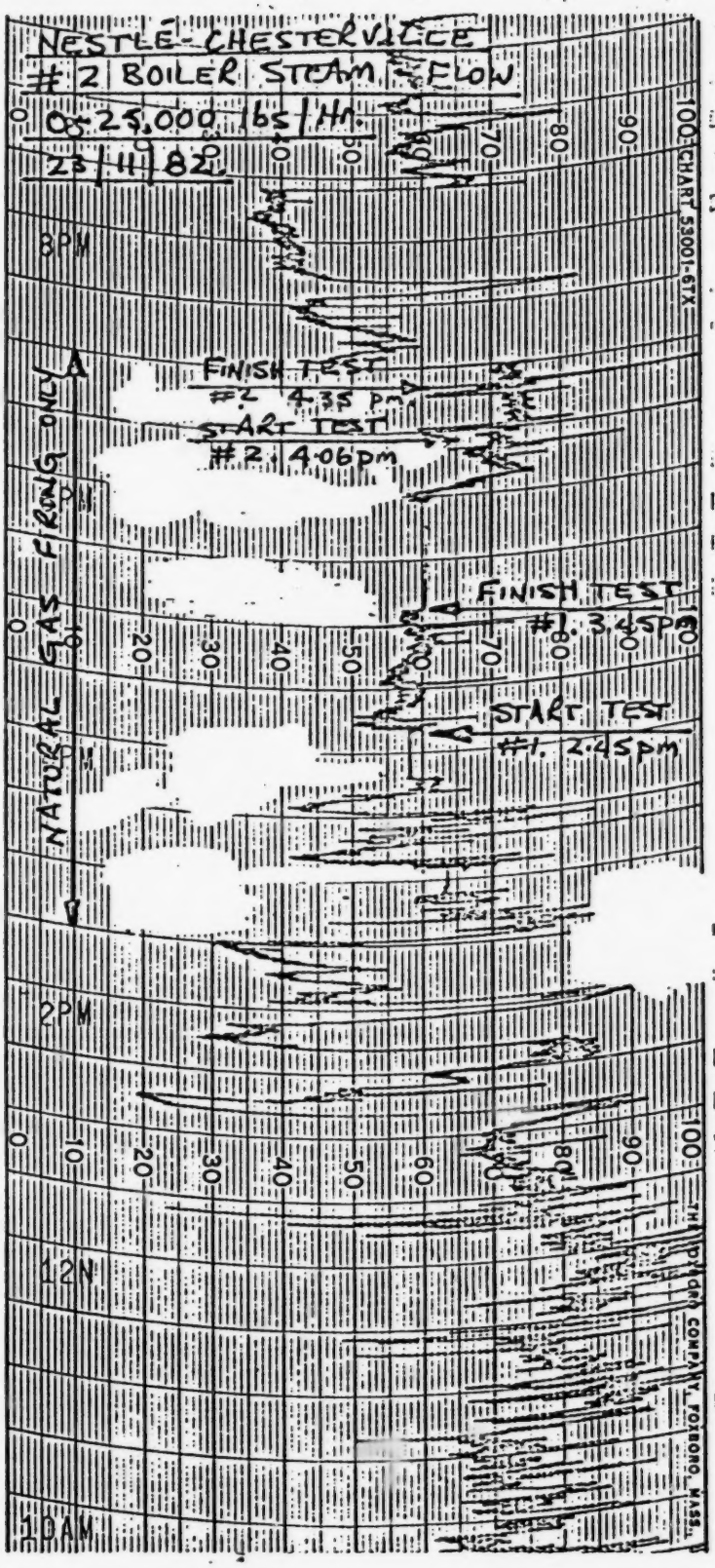

NESTLE-CHESTERVILLE
#2 BOILER STEAM FLOW
0-25,000 lbs/Hr.
2-3-11-82.
CHART 53001-6TX
8PM
FINISH TEST
#2 4.35 PM
START TEST
#2 4.06pm
NATURAL GAS FIRING ONLY
FINISH TEST
#1. 3.45PM
START TEST
#1. 2.45pm
2PM
12N
10AM
THE FOXBORO COMPANY, FOXBORO, MASS.

FIG. 1.

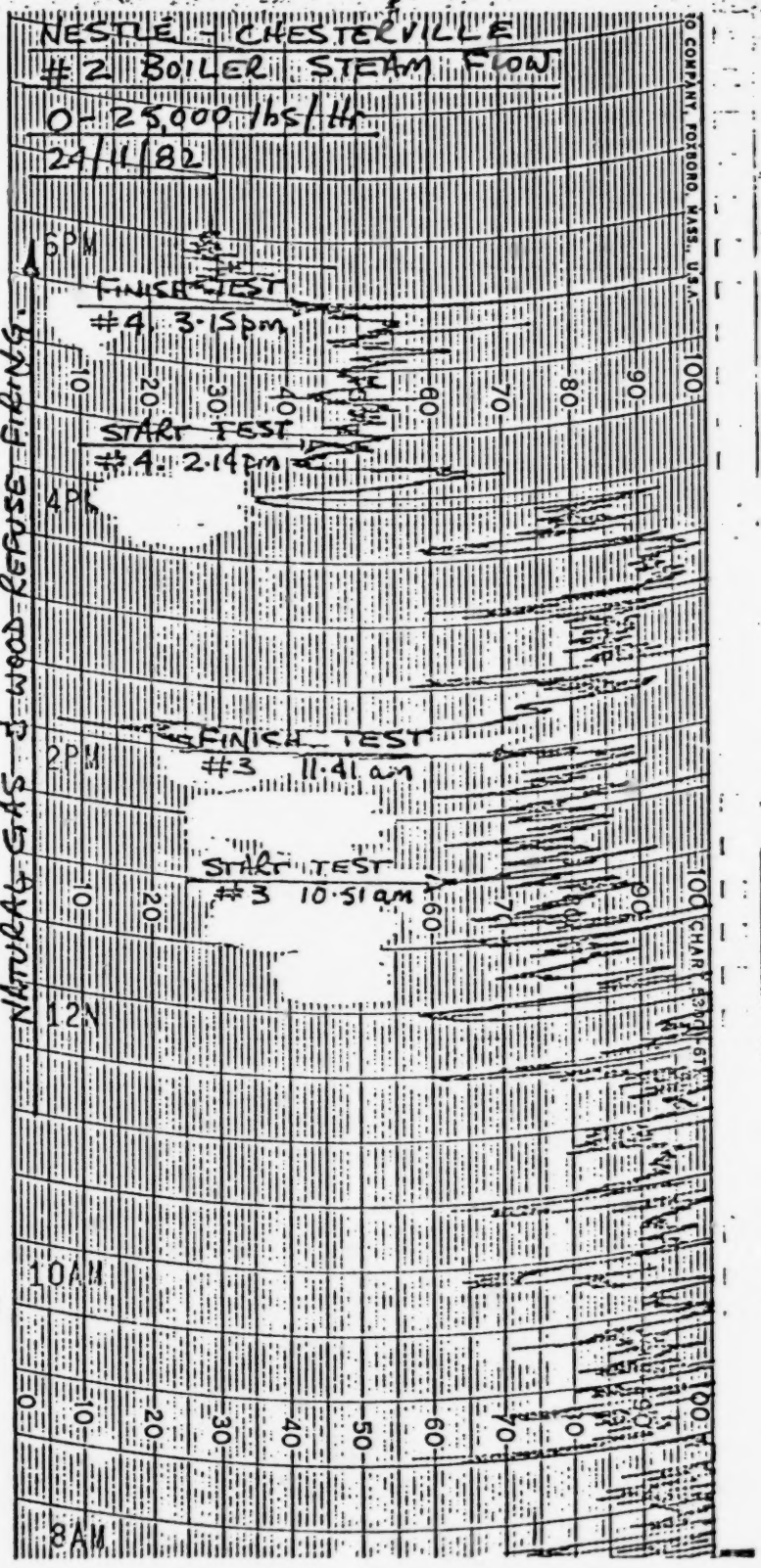

NESTLE - CHESTERVILLE
#2 BOILER STEAM FLOW
0-25,000 lbs/Hr
24/11/82
NATURAL GAS & WOOD REFUSE FIRING
FINISH TEST
#4 3.15pm
START TEST
#4 2.14pm
FINISH TEST
#3 11.41 am
START TEST
#3 10.51 am
6PM
4PM
2PM
12N
10AM
8AM
CHART
0
10
20
30
40
50
60
70
80
90
100

FIG. 2.

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Efficiency calculations
Input - Output method

Basic figures

Ultimate analysis of coffee grounds

Element	%
Carbon	55.02
Hydrogen	7.49
Oxygen	26.64
Nitrogen	5.95
Sulphur	0.08
Ash	1.23

Specific heat of coffee grounds - Assumed 0.5 BTU/lb

Higher heating value

@ Encore coffee grounds 10136.8 BTU/lb (DRY BASIS)

@ Natural gas 1000 BTU/ft^3

Boiler efficiencies

Test 1 NATURAL GAS FIRING ONLY

Steam flow 13,670lbs/hr

Natural gas flow 24,072CFH

Steam press 198 psig.

Feedwater temperature 180°F

$$\text{Efficiency} = \frac{\text{Steam flow (Enthalpy of steam - Enthalpy of F.W.)}}{\text{Fuel flow X Heating value}}$$

$$= \frac{13670\ (119 - 148) \times 100}{24072 \times 1000}$$

$$= 59.4\%$$

Boiler efficiencies (Cont'd)

Test 2 NATURAL GAS FIRING ONLY

Steam flow	177931bs/hr
Natural gas flow	29052 CFH.
Steam press	200.psig.
Feedwater temperature	212.5°F.

$$\text{Efficiency} = \frac{17793\ (1199 - 182) \times 100}{29052 \times 1000}$$

$$= 62.3\%$$

Test 3 NATURAL GAS + REFUSE FIRING

Steam flow	19,6871bs/hr
Natural gas flow	11,355 CFH.
Wt. of grounds	3,0001bs/hr
Temperature of grounds	110°F
Moisture of grounds	55.2%
Steam press	196 psig.
Feedwater temperature	197.3°F

$$\text{Efficiency} = \frac{\text{Steam flow (Enthalpy of steam - Enthalpy of F.W.)}}{\text{Total fuel X heating value + heat credits}}$$

$$= \frac{19687\ (1199 - 197)}{(11{,}355 \times 1000) + (3000 \times \frac{100 - 55.2}{100} \times 10136.8) + 3000 \times 31 \times 0.5}$$

$$= 70.3\%$$

Test 4	NATURAL GAS + REFUSE FIRING	
Steam flow	12,600lbs/hr	
Natural gas flow	12,036 CFH.	
Wt. of grounds	2,338lbs/hr	(WET)
Moisture of grounds	62.4%	(WET BASIS)
Temperature of grounds	118°F	
Steam pressure	196 psig.	
Feedwater temperature	198°F	

$$\text{Efficiency} = \frac{12{,}600\ (1199 - 166)}{(12036 \times 1000) + (2338 \times \frac{100 - 62.4}{100} \times 10136.8) + 2338 \times 44 \times 0.5}$$

$$= \underline{61.98\%}$$

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Summary of Efficiency Calculations
Heat Loss Method (Tests #1, #3 and #4)

Test #1 - 24,072 ct of Natural Gas.

1.	Dry flue gas losses @ 251% E.A.		21.0%
2.	Loss due to moisture		Nil
3.	Hydrogen loss		11.8%
4.	Loss due to combustible in refuse		Nil
5.	Loss due to CO in flue gas		Nil
6.	Radiation and Convection	less than	1.0%
7.	Unmeasured losses	less than	1.0%
	TOTAL LOSSES	less than	34.8%

Therefore boiler efficiency = (100 - 34.8) 65.2%

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Summary of Efficiency Calculations
Heat Loss Method (Tests #1, #3 and #4)

Test #3 - 11,355 ct of Natural Gas + 3,000 # Coffee Waste
@ 55.2 Moisture Content

1.	Dry flue gas losses @ 172% E.A.		14.2%
2.	Loss due to moisture content		4.5%
3.	Hydrogen loss		9.9%
4.	Loss due to combustible in refuse		Nil
5.	Loss due to CO in flue gas		Nil
6.	Radiation and Convection	less than	1.0%
7.	Unmeasured losses	less than	1.0%
	TOTAL LOSSES		30.6%
	Therefore boiler efficiency = (100 - 30.6)		69.4%

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Summary of Efficiency Calculations
Heat Loss Method (Tests #1, #3 and #4)

Test #4 - 12,036 ct of Natural Gas + 2,338# Coffee Waste
@ 62.4 Moisture Content

1.	Dry flue gas losses @ 240% E.A.		18.5%
2.	Loss due to moisture		4.1%
3.	Hydrogen loss		10.3%
4.	Loss due to combustible in refuse		Nil
5.	Loss due to CO in flue gas		Nil
6.	Radiation and Convection	less than	1.0%
7.	Unmeasured losses	less than	1.0%
	TOTAL LOSSES		34.9%
Therefore boiler efficiency = (100 - 34.9)			65.1%

Enersolve Demonstration Project
Nestlé Ltd., Chesterville, Ontario
BFH/S Reference 30901-7000

APPENDIX D

STATISTICS CANADA

COPY OF COFFEE STOCKS REPORT

1981-1982

CATALOGUE 32-025 QUARTERLY - TRIMESTRIELLE / ISSN 0709-2768 Vol. 3, No. 4

Statistics Canada Statistique Canada

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Autres pays, $3.00, $12.00 par année

PRODUCTION AND STOCKS OF TEA, COFFEE AND COCOA

PRODUCTION ET STOCKS DE THÉ, CAFÉ ET CACAO

QUARTER ENDED DECEMBER 1981

TRIMESTRE TERMINÉ EN DÉCEMBRE 1981

TABLE 1. Production and Stocks of Tea and Coffee, Canada, 1981

TABLEAU 1. Production et stocks de thé et de café, Canada, 1981

	Production		Stocks
	During the quarter Durant le trimestre	Year-to-date Total cumulatif	End of quarter Fin de trimestre
	metric - tonnes - métriques		
Coffee - Café:			
Green - Vert	...	...	7 522
Roasted, 1 pound (453 grams) and under - Torréfié, 1 livre (453 grammes) et moins	10 227	37 893	1 760
Roasted, over 1 pound (453 grams) - Torréfié, plus de 1 livre (453 grammes)	7 327	25 628	533
Instant - Instantané	2 730	10 665	406
Tea - Thé:			
Tea bags - Thé en sachets	4 542	15 307	1 694
Instant tea - Thé instantané	x	x	x
Loose tea - Thé en feuille:			
1 pound (453 grams) and under - 1 livre (453 grammes) et moins	194	724	95
Over 1 pound (453 grams) - Plus de 1 livre (453 grammes)	x	x	953

... figures not appropriate.
x confidential to meet secrecy requirements of the Statistics Act.

... n'ayant pas lieu de figurer.
x confidentiel en vertu des dispositions de la loi sur la statistique relatives au secret.

Manufacturing and Primary Industries Division

Division des industries manufacturières et primaires

February 1982
5-3305-747

Février 1982
5-3305-747

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PRODUCTION AND STOCKS OF TEA, COFFEE AND COCOA

QUARTER ENDED DECEMBER 1982

TABLE 1. Production and Stocks of Tea and Coffee, Canada, 1982

PRODUCTION ET STOCKS DE THÉ, CAFÉ ET CACAO

TRIMESTRE TERMINÉ EN DÉCEMBRE 1982

TABLEAU 1. Production et stocks de thé et de café, Canada, 1982

	Production		Stocks
	During the quarter Durant le trimestre	Year-to-date Total cumulatif	End of quarter Fin de trimestre
	metric - tonnes - métriques		
Coffee - Café:			
Green - Vert	...	...	6 677
Roasted, 1 pound (453 grams) and under - Torréfié, 1 livre (453 grammes) et moins	9 316	35 781	1 292
Roasted, over 1 pound (453 grams) - Torréfié, plus de 1 livre (453 grammes)	6 779	23 314	432
Instant - Instantané	x	8 791	330
Tea - Thé:			
Tea bags - Thé en sachets	3 726	15 174	1 456
Instant tea - Thé instantané	x	1 500	x
Loose tea - Thé en feuille:			
1 pound (453 grams) and under - 1 livre (453 grammes) et moins	273	897	79
Over 1 pound (453 grams) - Plus de 1 livre (453 grammes)	x	123	1 067

... figures not appropriate.
x confidential to meet secrecy requirements of the Statistics Act.

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List of Reporting Firms: Production and Stocks of Tea and Coffee

Liste des firmes déclarantes production et stocks de thé et café

Name Nom	Plant location Localisation de l'usine
New Brunswick - Nouveau-Brunswick	
Barbour Foods Ltd. (1, 2)	Sussex
Brooke Bond Inc. (1, 2)	Saint John
Québec	
Les Café Brésilian Limitée (1)	Montréal
Brooke Bond Inc. (1, 2)	Montréal
Brossard & Charette Ltée (1)	Montréal
Brossard Frères Inc. (1, 2)	Montréal
Café et Martican (1980) Ltée (1, 2)	Lachine
Desy Ltée, J.A. (1)	Montréal
General Foods Inc. (1)	Ville LaSalle
Produits London House Limitée (1, 2)	Montréal
La Maison de Café National Limitée (1, 2)	Montréal
Standard Brands Canada Limitée (1, 2)	Ville LaSalle
Les Aliments Steinberg Limitée (1, 2)	Montréal
Thé et Café Sterling Ltée (Montreal & sales outlet) (1)	Montréal
Ontario	
Club Coffee Company Ltd. (Div. of Standard Brands) (1, 2)	Don Mills
Excelsior Brands Ltd. (1)	Downsview
Fountain Brand Ltd. (1)	Brampton
Good Host Foods Ltd. (Rexdale & sales outlets) (1)	Rexdale
Hayhoe Foods Ltd., R.B. (1, 2)	Toronto
Kellogg Salada Canada Ltd. (All Plants) (2)	Rexdale
Lipton Limited, Thomas J. (2)	Toronto
Mother Parker's Foods Ltd. (1, 2)	Mississauga
Nabob Foods Ltd. (Plant at Ajax, Ont.) (1, 2)	Ajax
Nestle (Canada) Ltd. (1, 2)	Chesterville
Sandra Instant Coffee Co. Ltd. (Including Mississauga Plant) (1)	Ajax
Manitoba	
Brooke Bond Inc. (Winnipeg Plant) (1, 2)	Winnipeg
Melrose Foods Company (Div. of Standard Brands) (1, 2)	Winnipeg
British Columbia - Colombie-Britannique	
Brooke Bond Inc. (Burnaby Plant) (1, 2)	Burnaby
Dickson Importing (1, 2)	Vancouver
Empress Foods Ltd. (1, 2)	Vancouver
Goodhost Foods Ltd. (Vancouver sales outlets) (1)	Vancouver
Nabob Foods Ltd. (Plant at Burnaby, B.C.) (1, 2)	Burnaby

Note: The numbers shown after the Firm names relate to the items listed below and indicate the operations carried on by that Firm for this publication.
1. Coffee.
2. Tea.

Nota: Les chiffres figurant après les noms des Firmes correspondent aux articles énumérés ci-dessous et identifient le genre de produits conditionnés par cette Firme pour cette publication.
1. Café.
2. Thé.

POOR

QUALITY

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